#1832

TESTIMONY OF

DR. STEPHEN B. GOUGH

BEFORE THE

SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT

AND THE

SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION

HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY

ON:

THE IMPACT OF MERCURY RELEASES AT THE OAK RIDGE COMPLEX

OAK RIDGE, TENNESSEE

11 July 1983

This document includes: (1) information on mercury contamination of East Fork Poplar Creek, Oak Ridge, Tennessee; (2) possible monitoring efforts to assess ecological effects and health risk; (3) opinions on restoration and remedial measures; and (4) an account of the reaction of individuals within Union Carbide Nuclear Division (UCCND) to developments related to the mercury contamination. It is my understanding that extensive testimony will be presented by others on topics 1-3, including information based on more recent data than that available to me. Therefore, I will focus my remarks on item 4 and on those aspects of the other topics which may not otherwise be covered by other witnesses. Furthermore, I will limit discussion to the mercury issue, except for passing reference to other pollutants.

I was employed by Union Carbide Corporation from 1976 until June of last year. I voluntarily resigned for ethical reasons, and to avoid a probable reduction in force (RIF) action. During my tenure I was a researcher in the Environmental Sciences Division at Oak Ridge National Laboratory. My functions included environmental impact analysis for the Nuclear Regulatory Commission (NCR), the DOE and other government agencies; the procurement of new funding; the conduct and coordination of research in microbiology and toxicology; and the advisement of laboratory staff on water quality issues. I am now employed in Fredericksburg, Virginia, with System Development Corporation where I perform computer systems engineering, and provide supervisory/managerial support for military and biomedical projects. (See Biographical Sketch, Attachment 1).

Most of my remarks are provided in the form of a chronology spanning a five-year period. I feel this is a more coherent way to convey a relatively complex and multifaceted issue than to cover each point on a topical basis. Of necessity, my comments deal with historical information. While there is

validity in the comment, made recently by Mr. La Grone, that it can be "debilitating to worry about the past when much needs to be done in the present," elements of the past must be recognized to prevent recurrences of mistakes and to determine appropriate action for the future. It is in this spirit that comments regarding
improprieties are presented.

I wish to clarify a few major points which I sense may be misunderstood by some individuals; viz:

(1) Despite comments in the supervisor's report (Attachment 2), the sampling I conducted with my brother was only done to provide information to justify a proposal for research funding. There was no malice intended, and we both worked within the framework of the "system" as we perceived it. Even after I left the laboratory, information was funneled only to DOE (until after the majority of the facts were made public by others). It is true I felt there was a moral responsibility to pursue the issue to some logical conclusion, but no "a priori judgements" were made. I feel the sampling was totally within the realm of that expected of a productive and unbiased researcher who, by definition, should not be compelled to be concerned with whether he is perceived as an "environmental policeman" or whether an issue is "bureaucratically sensitive."

(2) The sampling and subsequent analysis was not done secretly or surreptitiously. My line management was informed of my activities and motives well in advance of the receipt of the data from the USGS.

(3) There were never any contentions that the sensitivity with regard to the sampling was in any way related to national security. This issue had been raised, appropriately, at an earlier date (during the K-25 environmental

assessment work) and resolved. While mercury inventories and similar data may have been classified (at the time), the fact that mercury was in the creek was not.

(4) It follows from the above that it is questionable if the sampling was really "unauthorized." This is especially problematic when it is realized that the official study done in reaction to our findings incorporates our data into its text without disclaiming them as unauthorized. Further, it was indicated to me that the reaction of the "system" to our actions would have been no different if the samples had been taken on private land within the city; i.e., the only item that resulted in a verdict of "unauthorized" was the fact that I was an employee.

While several points of a similar nature could be listed here, it is probably inappropriate to continue this discussion for this audience. Instead, such items will be (or have been) related to the Office of the Inspector General and/or DOE Operations for administrative review. Additional information relating to personnel actions is contained in the chronology (below) to provide some insight into the charges of information suppression.

As explained in the chronology, my brother and I collected samples of bryophytes and sycamore rootlets to provide a preliminary indication of trace metal values in plant tissues for the purpose of preparing a scientific proposal for detailed investigation. The results (Attachment 3) must be interpreted with extreme caution, especially if they are not coupled with other data. This is because the sampling was only done on one day, it only involved a few species and only select locations were sampled. For our purposes such "grab" sampling was adequate. Despite the preliminary nature of the findings, several statements can be made:

1. The mercury values were large and unusual, and replicate testing of the same material gave comparable values each time.

2. Other data available at the time of our analysis (e.g., the K-25 EA) suggested high mercury values were probable within the East Fork system, thus lending greater credence to the values.

3. Bryopytes are recognized indicators of heavy metal contamination. Like fish, the concentrations they display are often indicative of the degree of sediment contamination. Their value in predicting the degree of contamination of the East Fork is rather well upheld when comparisons are made with the data from the "official" ORNL May 1982 study (see ORNL/CF-82/257).

4. Taking into account all available plant tissue data (our samples and the samples from the study cited above), the upper reaches of the East Fork appear to have some of the highest plant mercury values in the United States. This may not have any health significance, however.

Since I only recently received the results of the May 1982 study, I presume Dr. Auerbach will discuss the report fully. Therefore, I will only refer to it briefly. The remarks which follow are generic and draw on several sources. Unfortunately, distance and lack of opportunity have probably precluded my use of much of the available data.

One reason the fish tissue mercury average is not higher is probably due to the hydrodynamics of the stream and the current location of the highest mercury sediment burdens. In other words, the highest sediment levels appear to occur closest to the headwaters, where the stream is shallow and large fish (which tend to have the highest concentrations per unit weight) are extremely uncommon. If the sediment mercury burden moves as a spike, higher fish tissue levels may result. The ability to assess this and other major events depends on an understanding of the geochemistry of the sediments, the spiraling (if any) of mercury within biota and the action of microorganisms. Understanding these factors requires much more monitoring and research than is available from the May 1982 ORNL study. Similarly, the recommendations made in that study are good but they do not go far enough.

It is difficult to imagine that any large-scale remedial measures, such as those being done by TVA and Olin in Saltville, Virginia, are either feasible or necessary at this time. If the use of the floodplain and stream proper continues to be restricted, and additional research/monitoring are conducted, restorative measures may never be instituted. However, it would be interesting to consider the resources needed, the probable impact, and the probable benefit to be derived from a limited dredging of the upper reaches (with cofferdams) coupled with a by-pass of New Hope Pond (to avoid any contribution from the pond sediments). Such an exercise may be purely academic, particularly when one realizes that the biggest unknown -- subterranean contamination -- may be a significant contributor. If dredging is considered, can the costs be partially offset by metal recovery?

The logistics of providing future accountability for control of discharges have probably already been set in motion by the task force formations and the extensive DOE-EPA (et al.) agreement(s) which have been promulgated. However, for the record, some of my thoughts on this are contained in a mailgram found in Attachment 8.

From the data I have seen so far, the situation appears to warrant reasoned concern, but certainly not panic. There are a few things I might do differently if I still lived in Oak Ridge, but not too many. Chief among them would be soil testing (if I had reason to suspect fill had been used), some change of fishing habits and restrictions on certain activities of children. The water supply would not concern me, nor would the air, unless I worked in one of the contaminated buildings.

The "bureaucratic sensitivity" appears to be turning around for the better. The actions and rhetoric of DOE, at least, indicate probable concern and an honest desire to change. Oak Ridge is moving in ways its citizens can take pride -- it should emerge a stronger, better city.

CHRONOLOGY:

This chronology contains a brief account of information on mercury contamination on the Oak Ridge Reservation which became known to me during my tenure at ORNL (1976-1982). To provide the subcommittees with some insight into alleged information suppression, the following also deals extensively with the manner in which mercury information was handled. Conjecture is purposefully avoided, where possible, to provide individuals the ability to form their own opinions. The material, of necessity, contains considerable information about my personnel history at ORNL.

During 1978 and 1979 I intermittently worked on the Environmental Assessment (EA) for K-25 (DOE/EA-0106, Environmental Assessment of the Oak Ridge Gaseous Diffusion Plant Site, December 1979). I wrote several sections which mention elevated mercury levels and which point to Y-12 as the probable source. Some of the sections also recommend additional action, such as more extensive monitoring and research, to assess whether any health or ecological effects are occurring. K-25 itself, which was scrutinized carefully for this assessment, appeared to do little environmental harm. The hydrological justrapositon of Y-12 and K-25 coupled with the other known contaminant sources made it evident that Y-12, the West End Sewage Treatment Plant and coal mine drainage are largely responsible for water quality degradation at the ORGDP site. Of these, Y-12's contribution seemed most significant in the area of mercury and PCB burdens. Other impacts, such as high organic loading, were not attributed to Y-12.

The EA's recommendations for further action on the mercury issue were similar to those given in J. Elwood's Central File (UCCND) Memo of 1977 (Elwood to Richmond, 6 June 1977, "Mercury Contamination in Poplar Creek and the Clinch River," ORNL/CF-11/320). Additionally, the idea of preventing or discouraging fishing by posting portions of the East Fork (and of Poplar Creek proper near K-25) were included in an early draft of my assessment but were "edited out" by others. This action, along with the difficulty I experienced in obtaining some of the extant data (e.g., I asked for Elwood's 1977 memo several times before receiving it), resulted in my first substantive awareness of the lethargy of the system in dealing with the mercury issue in a forthright manner. It was not clear to me then, as it is not clear now, exactly who considered the data "sensitive." In the Environmental Sciences Division (ESD) all the data except the K-25 assessment itself were considered "business confidential." It was presumed by most of us who worked with the mercury data that such a designation ultimately derived from higher management within UCCND or DOE.

My assessment was reviewed for technical accuracy by individuals within ESD who had extensive experience with heavy metal effects, particularly mercury. Among those consulted for formal or informal critiques were Dr. Jerry Elwood, Dr. James Loar (whose data I also used--see ORNL/TM-6714), Dr. J. Huckabee and Dr. S. Hildebrand. Additionally, the assessment received the customary managerial review to sanction it as an official ESD/ORNL submittal.

During my analysis of K-25 a draft document was discovered which mentioned mercury contamination. The "Three-Plant" Environmental Analysis (PDEA, Oak Ridge Operations, US ERDA, 1975-1976) was apparently begun in 1974 or 1975 to assess impacts from all DOE Oak Ridge facilities. Exactly who authored the draft is not known to me (except for a few of the individuals from ESD), and its ultimate fate is unknown. To the best of my knowledge it was never officially published. However, Volume X, Section 4.2.1.3, 1 August 1975, summarized the "unavoidable adverse environmental effects" of Y-12, stating "potential hazards to natural plant and animal communities....exist from the many heavy metals disposed of each year (i.e., mercury and cadmium)." It mentions other potential problems and another section (in Volume VII) is listed in a table of contents as containing a detailed description of environmental impacts. I do not recall seeing the latter discussion, and no mention is made of it in my notes.

The ORGDP assessment received DOE/HQ review. Many comments were received which indicated significant concern with regard to some of the contaminants in the East Fork. HQ also felt that certain issues were not addressed in enough detail (if an EIS was to be issued). For example, Ray Berube, Office of NEPA Affairs, wrote: "there is apparently significant contamination of surface waters with mercury and PCB, yet the sources have not been pinpointed." Based partly on the feeling that providing such detailed information was beyond the present scope, the document was "downgraded" to an environmental assessment (21 September 1979, letter to J. Boyle (ORNL) from J. Wing (DOE/ORO) re:ORGDP Environmental Impact Document).

Attachment 4 of this testimony contains excerpts from the ORGDP EA, including paragraphs specifically related to Y-12 mercury issue.

In 1980 I became involved in the planning for the environmental assessment slated to be done on the X-10 (ORNL) site (i.e., J. Boyle, et al. 1982, Environmental Analysis of the Operation of the Oak Ridge National Laboratory (X-10 Site), ORNL-5870). Although I attended a few scoping meetings and participated in some initial discussions on field sampling, I was ultimately reassigned to other projects. Attachment 5 includes a copy of a memo given to me by the author of the aquatic sections of the ORNL EA. It provides some preliminary perspective on the mercury issue at ORNL compared to Y-12.

Although my involvement in the Environmental Impacts Program of ESD decreased considerably during the ensuing years, I continued to maintain an interest in local impact problems. Thus, I helped ORNL Environmental Staff assess problems with nuisance plant growth on sewage ponds and participated in an effort aimed at monitoring and controlling Legionnaires' disease bacteria (LDB; Legionella) in the many cooling towers on the Oak Ridge Reservation. This latter effort was deemed sensitive from a public relations standpoint but was, by and large, handled openly.

During 1979 and 1980 I became an integral part of efforts to secure additional funding for research in the Aquatic Ecology Section. Successes in this regard included the procurement, with Dr. Richard Tyndall, of a 0.5 million dollar contract from the Electric Power Research Institute (EPRI) and of $300,000 from the Nuclear Regulatory Commission (NRC). Both projects were awarded to study environmental variables affecting Legionella in power plant environments. I became project coordinator (in addition to co-principal investigator) in the former effort.

It is with some hesitancy that I provide background information like the above, since it may not appear to provide data relevant to the hearing. However, since it has bearing on personnel matters (a later demotion, etc.) which were, I feel, a direct result of the mercury sampling, it is important in any consideration of information suppression. It is not my intent, however, to use my testimony as a "soapbox" since there are other, more appropriate forums for contesting an administrative action.

While the Legionella research projects provided important scientific information, the EPRI one was fraught with problems at the outset which were beyond my control. In particular, funding from it was continually redirected to other projects since I had very little actual spending authority. This was easy for management to do since the multi-subcontracted package was difficult to track at the best of times. I understand such fiscal "fudging" is fairly commonplace within a given organizational unit (e.g., division), especially during times of exigency. Further, it may not be illegal. However, it was not right to blame me for a shortage of funds in a project where such actions were taken when I did not perpetrate them and had, in fact, attempted to stop them (documentation available). I can only presume that such an accusation was easier to "legitimize" than that of impropriety due to "unauthorized" sampling for mercury. I reiterate that information such as this is included for background only to aid the reader in interpreting a rather complex situation. I will not encumber the reader with more tangential information than deemed essential.

My brother, Dr. Larry P. Gough, is a biogeochemist with the U.S. Geological Survey (USGS) in Denver, Colorado. In this capacity he conducts research on the concentration of elements in plants from both pristine and contaminated environments. On 3 December 1981, he visited me in Oak Ridge after attending a professional meeting in Atlanta. He had hoped to combine his visit with talks with researchers at ORNL. An illness precluded the latter, slated for 4 December 1981 (Friday). On 5 December, he and I discussed the possibility of joint research which would take advantage of our collective expertise and that of our parent organizations. (We had collaborated before on scientific efforts--most recently in the preparation of a manuscript for publication). From my knowledge of the lower reaches of the East Fork Poplar Creek, attained during my work on the ORGDP EA, we concluded that the stream might be very suitable for a study of trace metal dynamics in plants. To provide preliminary data to justify the preparation of a scientific proposal (to be submitted to DOE for joint DOE (ORNL)/USGS participation), we decided to take grab samples of mosses, liverworts and sycamore rootlets found within the stream. While we suspected we might obtain some interesting values, particularly after scrutinizing the ORGDP report's sediment data, we did not prejudge the results nor was the object of our effort aimed at uncovering any "scandal".

While the data were preliminary, when they were coupled with other information (e.g., the ORGDP EA) a case could easily be made that further study was warranted on scientific grounds. Furthermore, they were so extraordinary that the question of whether any health or ecological effects were possible was automatically an issue. I stress, however, that it may be some time before the latter issue is determined; much additional data are needed. In any event, there is no reason for extreme reaction. Perhaps more important than the contamination itself is the condition which allowed it to remain a "bureaucratically sensitive" issue for years.

Attachment 3 contains a two-page report on our sampling, the methods used, the values obtained and the significance and conclusions we derived from those values. It should be noted that values were to have been obtained for other heavy metals. Before S. I. Auerbach prohibited further analysis, arsenic concentrations were determined (these appear at the bottom of a memo in Attachment 6). Arsenic appeared elevated relative to what might be expected in plant tissues in the region but not to the same degree as mercury.

A charge has recently been made that the sampling was not technically sound because I did not first consult with ORNL mercury experts such as Dr. Elwood. In reality, I had talked with him (and others) on several occasions in the course of preparing the mercury analysis for the K-25 EA. Thus, while I may not have had as much research experience in mercury contamination as some individuals, I was by no means a stranger to the subject. Furthermore, my brother, a recognized expert on levels of elements in plants, had specific expertise which was not found among the mercury experts at ORNL. As I have stated repeatedly, the values determined were preliminary; any proposal written as a result of the findings would have included input from several other individuals from ORNL, USGS and elsewhere. Undoubtedly, we would have solicited many of the same ORNL individuals referred to above to perform some of the research. Unfortunately, we were never allowed to even outline a possible proposal.

Since ORNL later used our data in their own "official" report, which was instigated by our efforts, it doesn't seem likely that UCCND really views the sampling as unofficial. To the extent that I performed the sampling on my own time and utilized, through my brother, the facilities of the USGS, the effort was unofficial. But in no way do I view the sampling and analysis as clandestine. My immediate supervisor was informed of our intentions to write a proposal well in advance of the receipt of the laboratory analysis. Additionally, the reservation is commonly used by scientists for a wide variety of environmental studies (portions are designated a National Environmental Research Park to encourage such use), and no individual charged with being creative is asked to first "O.K." all of his creative hunches before proceeding in a limited fashion. In summary, generic permission to conduct sampling of the type we performed was implicit; explicit permission to collect plants (for example, algae at the Walker Branch Watershed) had been granted one year earlier. Because of this, and other factors, the severe reaction that ensued was not at all anticipated.

Around mid-January Dr. Van Winkle (immediate supervisor) was informed of the sampling and our desire to prepare a pre-proposal, or prospectus. (He would have been told earlier but the holiday/vacation period of mid-December through mid-January intervened). His reaction was not enthusiastic. I had anticipated some encouragement due to recent comments at the division level regarding increasing cooperative research between ORNL and other institutions.

It should again be noted that I have been repeatly assured that mercury in the creek is not a national security issue. I first asked this question when I worked on the ORGDP EA and learned of the contamination. While I have been told the information is considered "bureaucratically sensitive", (see supervisor's report, Attachment 3) no one has been able to coherently define this phrase for me. I believe it refers to the public relations implications of any disclosure of the information, and the fact that some individuals may be embarrassed by its disclosure or otherwise placed in an uncomfortable position.

Results of analyses for mercury became available in late February 1982 and were passed on to my supervisor. The two-page summary of the findings was finalized on 2 March 1982 (Attachment 3). This was given to my supervisor and a request was made that ORNL officially recognize the sampling so USGS could proceed with a cooperative effort (see draft letter to USGS from me for supervisory approval, Attachment 7). The request was denied. The reasons for the denial were not clear at the time, but they apparently followed the reasoning contained in the supervisor's report. Between this time and the end of my tenure at ORNL comments were made to the effect that the data should be kept to myself and that my brother should not divulge any information either. Dr. Van Winkle indicated that any impropriety on my part or my brother's might be countered by an action against my brother's career with the USGS. He indicated Mr. Wing (Environmental Protection Branch, DOE/ORO) had the ability to take such action. It was not clear whether Dr. Van Winkle was theorizing, and thus trying to be protective, or whether he had heard verbage to support this statement from officials above him. While neither my brother nor I felt there was any real substance to this threat, it was somewhat uncomforting. Actions taken against me were both subtle (e.g., "cold shoulder treatment") and overt (e.g., removal from position of top contender for Y-12 Environmental Coordinator position). It quickly became apparent that I should seriously look for another job. By 26 March 1982 I was ranked as one of four most likely to be terminated in a RIF from the Aquatic Ecology Section (documentation available).

On 1 April 1982 I was removed as Project Coordinator and Co-Principal Investigator of the EPRI Legionnaires' Disease Project. The reason cited was fiscal mismanagement. This was totally unfounded since the project's financial difficulties were were due to the actions of others (see above).

On 12 April 1982 S. I. Auerbach, Division Director, called the USGS and requested the return of all material relating to the 5 December 1981 sampling. My brother indicated that Dr. Auerbach stipulated that the material be returned without a cover letter. The USGS agreed because it did not wish to provide services which were not wanted, nor did it want to possess proprietary data. However, USGS personnel who were aware of the data indicated they would not perjure themselves, and they were concerned with the perceived impropriety of ORNL.

On 20 April 1982 I was told by W. Van Winkle that I was no longer being considered for the Y-12 Environmental Coordinator position due to my involvement in the mercury "incident," despite having been the candidate of choice from the Environment Sciences Division (documentation available).

On 28 April 1982 I was verbally "reprimanded" by S. I. Auerbach for the sampling. My immediate supervisor, W. Van Winkle, was also present and prepared a synopsis of the meeting (supervisor's report, Attachment 2). One important point was not recorded. When I asked if the reaction of Auerbach and others would have been any different if the samples had been taken within the city (i.e., not on the DOE Reservation), the answer was "no." I did not feel it was necessary to respond in writing to the report.

In May of 1982 a few people from the Environmental Sciences División were selected by management to conduct a follow-up study in response to the December 1981 sampling. As I was not allowed to participate in the effort, except to a very minor extent at the outset, the details of the sampling design and the results obtained were not known to me until very recently. I did attend an initial scoping meeting, called by W. Van Winkle, to determine whether a concensus of selected researchers agreed that further study was warranted. (Everyone in attendance strongly felt additional scrutiny was desirable). It seemed evident that the managerial motives for conducting the monitoring were not necessarily scientific.

At least one of the participants (Dr. Elwood) had tried to promote efforts similar to those discussed for the "crash monitoring program" as far back as 1977, but he reiterated that he had had very little success. He also reported on his concerns with regard to the sampling design and analytical techniques used by DOE in preparing its annual environmental reports. He mentioned a memo on the subject he prepared for S. I. Auerbach and C. R. Richmond (ORNL Assoc. Laboratory Director).

I was later asked to reenact the 5 December 1981 bryophyte/sycamore rootlet sampling, and the resulting analyses were made available to me (see Table, 6, page 42, ORNL/CF-82/257). These were the only data I was allowed to see at that time.

On 26 May 1982 I was offered another position in Fredericksburg, Virginia (my present one) and I accepted. I applied for a voluntary reduction in force (VRIF) action to take effect in two weeks. ESD management (Auerbach) requested that I stay an extra week to complete certain tasks; after consultation with my new employer, I agreed. At that point, a VRIF was approved and I was thereby promised separation pay. 18 June 1982 was my effective date of resignation.

In July 1982 I had a chance encounter with Mr. Jon Bogott, Supervisory Criminal Investigator, DOE's Office of the Inspector General (he purchased my Oak Ridge house). During the course of a conversation the subject of his job responsibilities surfaced, and I mentioned possible improprieties with regard to the handling of mercury contamination information. At the time I was not willing to provide specifics or otherwise become an "informant." On 9 September

1982 Mr. Bogott asked if I would seriously consider becoming a confidential informant. Due to previous threats, both implicit and explicit (e.g., re: my brother's career), and my preoccupation with establishing myself in a new career (etc.), I was reluctant but did accept. Mr. Bogott quickly gained my complete respect and trust as he cautiously pursued his investigation. (It now appears probable that his initiation of an investigation indirectly resulted in the disclosure of the "mercury situation," beginning with the state's acquisition of a portion of the 1982 data, and climaxing in the declassification and release of the 1977 "discharge" report).

On 13 September 1982 I called my former section head (Van Winkle) to request a copy of the report resulting from Union Carbide's May 1982 study (now known to be ORNL/CF-82/257). The request was denied on the grounds that the information was proprietary--"business confidential". While I realized the report could be accessed under the FOI Act (DOE facilities and equipment were used) I did not care to pursue the matter further.

In November 1982 I read an "Oak Ridger" article indicating the creek was to be posted. While my professional curiousity was not satisfied, much of my concern that the public was not adequately informed was diminished.

On 18 May 1983 I was asked by Mr. Bogott if I would agree to waive my right of confidentiality to enable his office to more expeditiously pursue their investigation. I agreed and also gave him authority to access my personnel file.

I am continuing to cooperate to the fullest possible extent with the Office of the Inspector General. Copies of all pertinent files, including many of tangential significance, have been given to Mr. Bogott. Thus, while I have attempted to be thorough in this testimony, it is not practical (or of likely relevance) to include all such material here. However, I would be happy to provide any additional information, if desired.

ATTACHMENT 1

ATTACHMENT 1.

BIOGRAPHICAL SKETCH:
Dr. Stephen B. Gough
8 Norman Court
Fredericksburg, Virginia 22401

Stephen Gough received his B.S. in Biology/Chemistry (Magna Cum Laude) from Carroll College in 1972. He received his Ph.D. in Botany, Oceanography and Limnology from the University of Wisconsin-Madison in 1976. For six years thereafter he was a research biologist in the Environmental Sciences Division of Oak Ridge National Laboratory. For the past year Dr. Gough has been a software system engineer and a task leader with System Development Corporation (SDC), Fredericksburg, Virginia. He was recently named Lead Analyst for a major software system employed by the Navy and serviced by SDC.

His experience and training is broad and includes: (1) a biomedical undergraduate indoctrination: (2) course work and research in ecological sciences; (4) applied environmental work, including contributions to numerous impact analyses and the appearance as an expert witness at adjudicatory hearings; (5) research and project management in environmental health (e.g., Legionnaires' disease bacteria); (6) development of toxicological monitoring protocols for the EPA; (7) consulting and planning with regard to various water quality issues, such as nuisance plant growth, excessive nutrient problems, heavy metal inhibition of waste treatment processes, and dissolved oxygen problems; (8) the refinement of the use of indicator organisms/indices of aquatic pollution; and (9) the application of system science to complex technological and biomedical problems.

Dr. Gough holds a "Top Secret" security clearance. He is a member of several professional societies and is an author or coauthor of nearly twenty technical papers. He is a coauthor of a book on hydrologic and ecological features of the contiguous United States.

ATTACHMENT 2

UNION CARBIDE CORPORATION
NUCLEAR DIVISION

SUPERVISOR'S REPORT

DATE OF INTERVIEW

EMPLOYEE'S NAME: Stephen B. Gough

BADGE NO.: 16558

DEPARTMENT NO.: ESD (42)

REASON: Collection of unauthorized samples relating to a sensitive issue

DETAILS

Gough met with S. I. Auerbach and W. Van Winkle. Auerbach initiated the meeting by asking Gough why he and his brother (Larry Gough, Branch of Regional Geochemistry, U.S. Geological Survey (USGS), Denver) had collected the samples. (The samples of concern were samples of mosses, liverworts, and willow roots collected Saturday, December 5, 1981, at three sites on East Fork Poplar Creek and one site on Bear Creek. The samples were analyzed for mercury in his brother's USGS laboratory). Gough responded that the idea came up spontaneously that Saturday when his brother was visiting. His brother's professional interests center on levels of trace metals in plant tissues, and Steve knew the East Fork Poplar Creek would be an interesting aquatic system because of his experience in preparing the K-25 EIS in 1980.

Auerbach pointed out that after being here six years he would expect an employee to know how the system works, and that he is astounded that Gough did not perceive the sensitivity of this issue. Gough responded that he did know the Y-12/Hg issue was sensitive, but that at the time he had not viewed the collection of samples as inappropriate. Auerbach responded that Gough had shown poor judgment and that the proper approach would have been to work through the system, regardless of the perceived low probability of obtaining authorization to collect such samples.

Auerbach asked Gough if he understood the message being communicated at this interview. Gough responded that he believed in working within the system and that with this "injudicious" exception he had. Auerbach pointed out that we cannot appoint ourselves as environmental policemen and that we must accept the constraints of the system, especially within the context of the policies of the sponsoring government agency.

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EMPLOYEE'S ACKNOWLEDGMENT OF RECEIPT OF COPY

SUPERVISOR'S SIGNATURE: W. Van Winkle

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FILE
OTHERS AS REQUIRED
S. I. Auerbach
C. R. Richmond

UCN-268
1235 12-73)

Auerbach brought up the need to guard against making an a priori judgment, even subconsciously, that there is a problem in a particular situation. The analogy with leakage from low level radioactive waste pits was discussed. With both this issue and the Y-12 /Hg issue relatively extensive monitoring has not demonstrated a health problem or an ecological effects problem. However, there is a sociological problem, and thus a potential economic problem, if this type of sensitive information is handled inappropriately. With both these issues what can be said is that further study and monitoring are needed because there may be a problem on subissues about which we have insufficient information, which was Gough's primary motive in collecting the samples.

The entire interview was cordial and ended on the note that every organization has guidelines by which one is expected to function and which must be understood and accepted, even if we do not like all of them. Gough's actions constitute an unintentional "misdemeanor" and not a "felony." Some good may have been accomplished in terms of stimulating further monitoring of mercury on the reservation. However, this was the wrong means for achieving such an end, and it is not a behavior pattern to continue.

Gough apologized for the problems he had caused and assured us that this one act was not indicative of a generic inability to perceive bureaucratically sensitive situations.

ATTACHMENT 3

Collections

The results of the analyses for total Hg in samples of aquatic bryophytes (mosses and liverworts) and plant roots that we collected at sites along Bear Creek and E. Fork Poplar Creek on Dec. 5, 1981 are listed below:

	Mercury, ppm dry material		
Poplar Creek	Moss	Liverwort	Sycamore Tree Rootlets
Site 1	30	18	n.a.*
Site 4	9.0	n.a.	n.a.
Site 3	4.0	n.a.	n.a.
Bear Creek			
Site 2	n.a.	.14	.14

*n.a. means samples not available for collection.

Site 1: Approximately 400 m below the intersection of Bear Creek and Scarboro Roads. Stream shallow (<20 cm), narrow (5-6 m wide), with rocky bottom. Samples taken on east side of E Fork Poplar Creek several centimeters above present water level. Mosses and liverworts growing on both tree roots and sediments.

Site 2: Approximately 0.75 mi. south of intersection of Oak Ridge Turnpike on White Wing Rd. Bear Creek was slow moving, shallow, and narrow (2-3 m wide) with a rocky bottom. Liverwort samples were collected several centimeters above present water level on sediment. Sycamore tree rootlets were collected in shallow pools where they were submerged and suspended (not anchored in the sediment).

Site 3: Approximately 500 m below confluence of Bear Creek and E Fork Poplar Creek. Stream width ca. 8-10 m. Moss samples collected on south side about 1.5 m above present water level on limestone slabs.

Site 4: Approximately 2 mi. upstream from confluence of Bear Creek and E Fork Poplar Creek just north of Oak Ridge Turnpike near bridge over E Fork Poplar Creek. Stream width ca. 8-10 m. Samples taken several centimeters above present water level on tree limbs and roots.

Methods

All samples were prepared for Hg analysis as follows:

1. Soaked over night in tap water.
2. Picked clean by hand--removal of sediment and extraneous plant material.
3. Rinsed in running tap water (material recovered on a stainless steel screen).
4. Twice rinsed in distilled water.
5. Dried in a forced-air oven for 24 hrs. at about 35°C.
6. Ground in a Wiley mill to pass a 1.3 mm screen.

7. Digested with nitric, sulfuric, and perchloric acids under reflux.
8. Stannous chloride added to digestate to reduce the Hg to its elemental state.
9. Mercury swept from solution by air into an absorption cell attached to an atomic absorption spectrophotometer.

Concentrations of Cd, Pb, and As in these samples are also being determined.

Significance and Implications

The mercury levels found in the moss and liverwort samples collected along E Fork Poplar Creek are large and can be considered very unusual. The 30 ppm concentration obtained for the moss sample from Site 1 was the largest ever measured in plant material in our Plant Laboratory. This moss sample, as well as the liverwort sample from the same site, yielded the same high concentrations when re-analyzed. Studies by botanists in our Branch over the years have shown that plant material usually contains <1 ppm (1,000 ppb) Hg and levels of <0.07 ppm (70 ppb) are common. For example, the range of Hg concentrations in big sagebrush samples at 190 sites throughout its distribution in the western U.S. was 0.01-0.06 ppm. Mercury values of about 3.5 ppm have been found in shrub samples that were rooted in a cinnabar deposit in northern Canada and recently a Hg concentration of 7 ppm was recorded in a bryophyte sample from a mineralized region in Nevada.

The Poplar Creek values thus are of interest because of their extreme nature in a region where Hg deposits are not known. It would appear that an anthropogenic point source for Hg is the most reasonable explanation for such large concentrations. A pronounced gradient in Hg levels occurs with the largest values near the headwaters (Site 1) and progressively decreasing values going downstream. The values for liverwort in Bear Creek, although large compared to plants in general, are much smaller than those in samples from Poplar Creek.

A few of the scientific questions that come to mind follow:

1. What is the source and form of the Hg?
2. Is the Hg being concentrated anywhere in the foodchain?
3. What physical, chemical, or biological processes are mobilizing the Hg?
4. Are any other metals present in large concentrations?
5. Are aquatic vascular plants also concentrating Hg?
6. Assuming a cessation of the Hg contamination, how much time would be required for the stream vegetation to approach background levels?

ATTACHMENT 4

This attachment includes
excerpts from this document.

DOE/EA-0106

ENVIRONMENTAL ASSESSMENT OF THE OAK RIDGE GASEOUS DIFFUSION PLANT SITE

December 1979

Oak Ridge Gaseous Diffusion Plant
Oak Ridge, Tennessee

TECHNICAL INFORMATION CENTER
UNITED STATES DEPARTMENT OF ENERGY

ENVIRONMENTAL ASSESSMENT OF THE OAK RIDGE

GASEOUS DIFFUSION PLANT SITE

Sections and Pages Pertinent to Y-12 Mercury Issue.

Electric power (about 2080 MWe consumed in 1984) is supplied by the Tennessee Valley Authority. About 6.6% of TVA's generating capacity is committed for use by ORGDP. Since specific dedicated plants do not supply this power, the environmental impacts of supplying ORGDP power are considered a proportion of the total environmental impact of the operation of the TVA network of hydroelectric, coal, and nuclear generating facilities. Based on the projected mix of TVA generating facilities for 1984, the facility breakdown will be about 300 MWe hydroelectric, 1200 MWe coal, and 1050 MWe nuclear.

A 300-MWe hydroelectric generating facility would likely inundate about 550 acres of land, resulting in associated land-use changes and the disturbance of associated terrestrial and aquatic biota.

Impacts from a 1200-MWe coal-fired generating facility result from mining, transportation, storage, combustion, and waste disposal. Typically, 400 acres of land is used for the coal-fired facility and 150 acres/year for surface mining (assuming the coal is supplied by surface mining of eastern coal). A possible 700 acre-ft of water is required annually in surface mining. Approximate amounts of pollutants discharged to the atmosphere (assuming the plant conforms to New Source Pollutant Standards) annually would be: SO_2, 28,000 tons; NO_x, 16,000 tons; particulates, 2000 tons; hydrocarbons, 3000 tons; CO, 1000 tons; lesser amounts of various metals; and about 23 Ci of radioactivity. These pollutants cause adverse health effects, primarily to the human respiratory system. Transportation of the coal from the mines to the generating plant causes increased traffic on the highways and railroads, resulting in increased accident potential, as well as increased emission from the internal combustion engines. Streams are polluted from surface mining operations, coal piles, and ash pits.

A 1050-MWe nuclear facility would require about 1500 to 2000 acres of land for the plant (250 acres) and buffer zone. About 5000 acre-ft of water is consumed annually, and terrestrial impacts result from cooling tower drift. As with coal mining, land is disturbed for uranium mining. Environmental issues related to uranium milling are sulfate emissions, low-level radiological releases, mill tailings disposal, and water consumption. The radiation dose to the surrounding population from the radioactivity released in nuclear plant effluents would increase possibly 2% over natural background levels.

The effects of potential accidents are evaluated. In the scenario where the entire contents of a 14-ton cylinder of UF_6 is released to the atmosphere within a 15-min time span, calculations show that lethal concentrations of HF could exist in the parking lot (open to the public) for a period of time. The concentration of HF would be 2300 mg/m^3; 1000 mg/m^3 is lethal. The radiation dose from the uranium released could result in a dose of 65 rem to the total body and 750 rem to the bone. The rupture of an anhydrous hydrofluoric acid storage tank could release twice as much HF to the atmosphere as the 14-ton UF_6 cylinder. All other accidents considered are more than an order of magnitude less severe.

1.6 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

Unavoidable adverse environmental impacts of ORGDP operation that may occur on the Oak Ridge Reservation near the plant are primarily a function of air quality deterioration. Under severe meteorological conditions, Tennessee ambient air quality standards for HF may be exceeded near the plant. Cooling tower plumes are visible offsite, and they occasionally touch the ground. The frequency of ground-level fogging along Tennessee Highway 58, adjacent to ORGDP, is estimated to be 16% greater than the frequency of fogging without plant operation.

The operation of ORGDP contributes to the chemical loading of Poplar Creek and the Clinch River. During periods of low flow or no flow, severe local aquatic impacts (toxicity, eutrophication) may occur, but the effects from such episodes should be transient, with the possible exception of increased heavy-metal body burdens in aquatic biota.

Operation of the plant through the year 2000 will use 20 acres of land for landfill disposal of radioactively contaminated wastes and 2 acres for sanitary wastes.

The total population living within 50 miles of ORGDP receives a total-body radiation dose of 0.044 man-rem/year. This is only about 0.00006% of the dose received by the population from natural background. Maximum-dose estimates for offsite individuals at the boundary fence 4 km SW of the plant are 0.0037 millirem/year for the total body and 0.00023 to 0.041 millirem/year for body organs. This does not add significantly to the individual's annual radiation dose from natural sources.

Table 4.8. Water quality data for selected parameters measured at three Clinch River stations[a,b] upstream of ORGDP sanitary water intake

Parameter	Concentration (mg/liter)								
	Transect 1, station 5			Transect 4, station 3			Transect 5, station 5		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Total alkalinity, as $CaCO_3$	96	76	114	98	76	116	93	76	106
Hardness (total), as $CaCO_3$	112	96	136	115	88	138	111	82	136
Calcium[c]	N.A.[d]	N.A.	N.A.	33.5	24.0	43.0	N.A.	N.A.	N.A.
Magnesium[c]	N.A.	N.A.	N.A.	7.8	7.0	8.5	N.A.	N.A.	N.A.
Iron (total)[c]	N.A.	N.A.	N.A.	0.38	0.08	0.68	N.A.	N.A.	N.A.
Chloride	5.0	2.6	13.0	4.7	2.0	11.0	4.6	1.0	10.0
Potassium	1.4	1.1	1.7	1.4	1.1	1.9	1.3	1.1	1.6
BOD	2.1	0.3	6.0	1.8	0.9	3.0	2.2	<1.0	3.4
Total organic carbon	4.0	1.0	10.0	4.5	1.0	9.0	3.2	1.0	6.0
Phosphorus[e]									
Ortho PO_4^{3-}-P	0.026	<0.003	0.120	0.013	<0.003	0.060	0.015	<0.003	0.100
Total PO_4^{3-}-P	0.041	<0.003	0.130	0.049	<0.003	0.230	0.064	<0.003	0.350
Nitrogen[e]									
NO_2^--N	0.010	<0.001	0.068	0.010	<0.001	0.062	0.001	<0.001	0.065
NO_3^--N	0.010	<0.001	0.068	0.010	<0.001	0.062	0.001	<0.001	0.065
NH_3-N	0.2	0.1	0.5	0.3	0.1	0.5	0.2	0.1	0.5

[a]Data were collected from March 1974 through April 1975.
[b]Transect and station locations are shown in Fig. 1.4-1 of source note 2 (see below).
[c]Samples were only taken in March and September 1974 at transect 4, station 3.
[d]N.A. = data not available.
[e]For calculation of mean values, levels under the limit of detection were considered to represent one-half the detection limit value.

Sources:

1. Project Management Corporation and the Tennessee Valley Authority, *Clinch River Breeder Reactor Project Environmental Report,* Construction Permit Stage, Docket No. 50-537, Apr. 2, 1975, Tables 2.7-32 and 2.7-35.
2. James M. Loar et al., *Environmental Analysis Report for the Oak Ridge Gaseous Diffusion Plant,* ORNL/TM-6714, Oak Ridge National Laboratory, Oak Ridge, Tenn. (in preparation).

Ammonia concentrations in the Clinch River and Poplar Creek at times exceed recommended levels for the protection of aquatic biota. The presence of the toxic unionized form depends strongly on pH; little is present at pH values below 7. At pH 8.3 (the maximum recorded in the vicinity; see Table 4.7), 10% of the ammonia is NH_3.[20] Under such conditions, the criterion for the protection of aquatic biota[21] of 0.02 mg/liter would be exceeded at most of the stations listed in Table 4.7. The implications of this for the aquatic biota, as well as the effects of other potential toxicants found in the area's waters, are discussed in Sects. 5.2.2, 5.3.3, and 5.3.4.

✓ Mercury in the water was found in concentrations significantly above background (Table 4.7) at all area sites (Fig. 2.14) sampled during the ORGDP monitoring program.[15] Levels of up to 0.003 mg/liter were recorded; background concentrations in this area should not exceed 6×10^{-5} mg/liter (0.06 μg/liter).[22] The mean concentrations at all the stations are below the detection limit used in the available studies (0.001 mg/liter), but this level is above the current standard for the protection of aquatic biota — 5×10^{-5} mg/liter (0.05 μg/liter).[21] Thus, average concentrations at the sampling stations may exceed the water quality standard.

Of the eight other heavy metals analyzed in the available studies, only zinc was found to occur in concentrations potentially harmful to biota (Sects. 5.2.2 and 5.3.3).

PCB concentrations were determined at five locations in Poplar Creek and the Clinch River; all values were below the 0.0005-μg/liter limit of detection.[15] Concentrations below 0.001 μg/liter are not believed to significantly affect aquatic biota.[21]

4.4.1.4 Sediment quality

Several studies of heavy-metal concentrations in sediments were conducted in the vicinity of ORGDP.[15] Table 4.9 summarizes the data from the most complete evaluation. (The sampling locations are shown in Fig. 4.5.) The data for many of the elements display a high degree of variability — both in differences among sampling sites and among sampling dates. For some of the parameters, analytical methods were changed during the course of the investigation, thereby potentially altering the precision and accuracy of the determinations. For comparison, a compilation of published values representative of largely uncontaminated areas is provided in Table 4.10. Likewise, Table 4.11 lists mercury concentrations in various sediments, from both contaminated and relatively pristine locations.

Cadmium levels in the sediments near ORGDP may be elevated above concentrations expected in an uncontaminated environment (cf. Tables 4.9 and 4.10), but the precise concentration of cadmium cannot be determined from the data because the detection limit of the analytical method used was 5 μg/g dry weight. Chromium concentrations appear to be elevated (at least, at some sampling locations), as do levels of the other heavy metals measured (copper, lead, manganese, mercury, nickel, and zinc). All these metals currently are discharged at one or more locations at ORGDP (Sect. 2.2.3.3). The mercury values are particularly noteworthy — some of the concentrations found are up to five orders of magnitude greater than those found in relatively pristine areas and up to two orders of magnitude greater than values determined for other contaminated locations (cf. Tables 4.9, 4.10, and 4.11). For example, the highest reading, from a Poplar Creek sample, was 307 μg/g (dry weight); for comparison, an uncontaminated British stream was 0.03 to 0.17 μg/g, and the heavily polluted Rhine River was 6.90 μg/g. More than 80% of all sediment samples from the mouth of Poplar Creek to its confluence with the East Fork of Poplar Creek had mercury levels >1.0 μg/g; more than 33% had values >10 μg/g. However, sediment concentrations varied greatly among sampling sites on a particular sample day and among sampling dates at a given site. Sections 5.2.2 and 5.3.3 contain additional information on mercury distribution, as well as a discussion of the potential impacts of elevated mercury levels. It is believed that the source of current mercury levels in the ORGDP area of Poplar Creek results from past operations at Y-12.[23]

Data on sediment concentrations of polychlorinated biphenyls (PCBs) indicate that levels in Poplar Creek are higher than in the Clinch River. A 1974 study of six stations on Poplar Creek revealed levels ranging from 6 to 15 μg/g ($\overline{X}$ = 11 μg/g), although another survey (of different stations) reported concentrations that were roughly an order of magnitude smaller.[15] In comparison, nearly all values for Clinch River sediment samples were <0.1 μg/g, and a few were <0.001 μg/g. PCB effects on biota are discussed in Sect. 5.2.2.

4.4.1.5 Water use

The ORGDP currently takes about 12 Mgd (19 cfs) of water from the Clinch River for makeup cooling water; this will be increased to about 20 Mgd (31 cfs) by 1984 (Sect. 2.2.3.3). The sanitary water demand is about 4 Mgd (6 cfs) and is not expected to increase substantially over the next few years. These withdrawals, taken at Clinch River Mile (CRM) 11.5 and 14.4, respectively, would be (in 1984) only about 6% of the seven-day, ten-year low flow and only about 1% of the average flow. Additionally, about 25% of the water will be returned to the river as treated sewage or as blowdown water. Currently, no withdrawals are made from Poplar Creek, although several effluent release points are located on it (Sect. 5.3.3).

Other industries and municipalities in the vicinity of ORGDP that use water from the Clinch River include DOE Oak Ridge Operations (ORNL and Y-12 Plant) and the city of Oak Ridge (22 Mgd at CRM 41.5) and the TVA Bull Run Steam Plant (572 Mgd at CRM 47.6).[2] All are upstream from ORGDP.

The Clinch River (including Melton Hill and Watts Bar reservoirs) adjacent to the reservation is a component of the Inland Waterway System, which allows commercial navigation to the Gulf of Mexico. Commercial traffic locked through Melton Hill Dam amounted to 3000 tons (2720 metric tons) in 1975. In 1974, 631 recreational craft passed through the Melton Hill locks.[14]

ES-4693

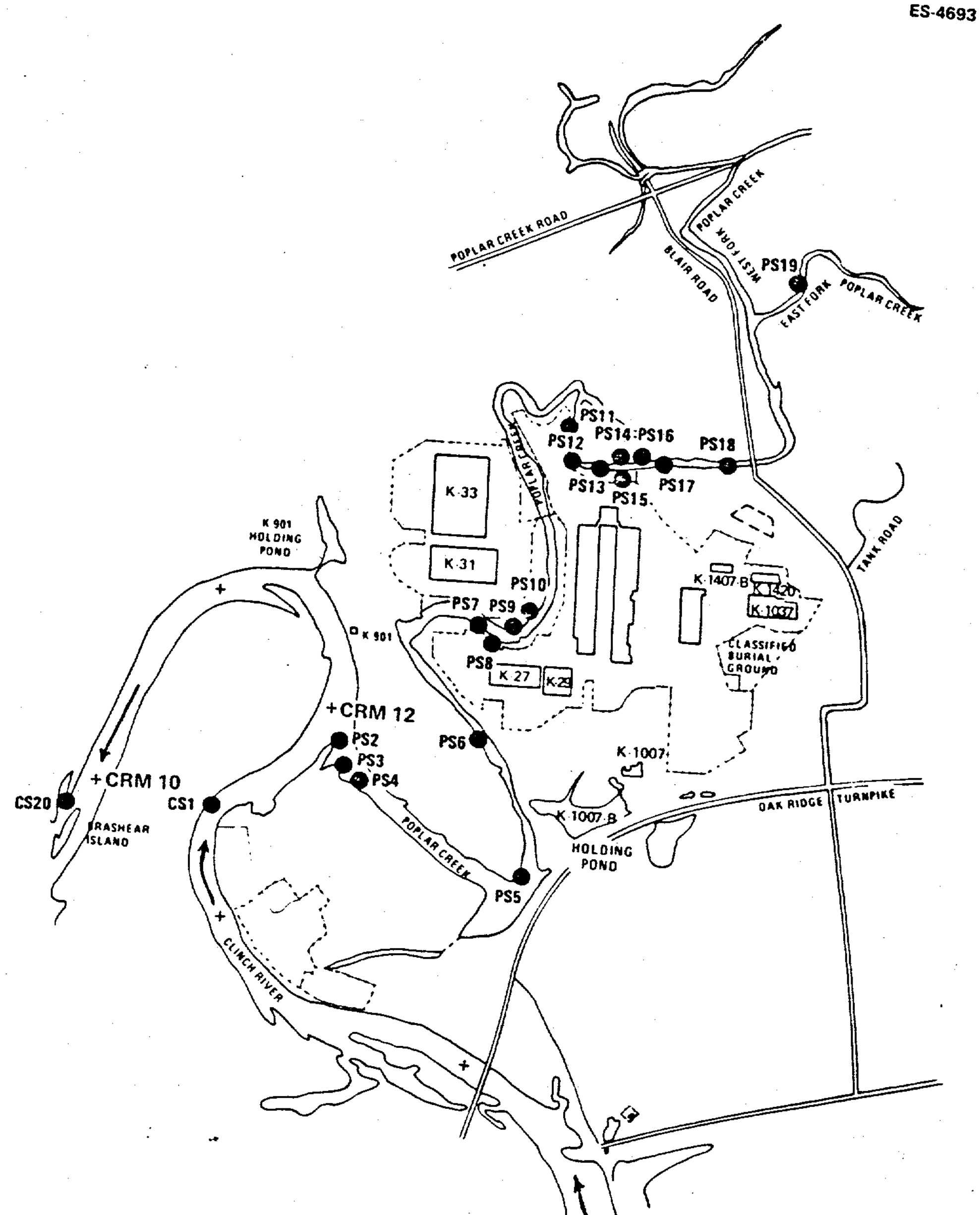

Fig. 4.5. Surface-water sediment sampling stations surveyed in July and November of 1976 and 1977 for aluminum, cadmium, chromium, copper, lead, manganese, mercury, nickel, and zinc. Source: James M. Loar et al., *Environmental Analysis Report for the Oak Ridge Gaseous Diffusion Plant*, ORNL/TM-6714, Oak Ridge National Laboratory, Oak Ridge, Tenn. (in preparation).

Recreational use of the waters in the Oak Ridge area is heavy. Although no quantification of the activities is available, swimming, fishing, and localized recreational boating are very popular. The Clinch River and its reservoirs are primarily used for these sports, but smaller tributaries (such as Poplar Creek) are frequently fished (Fig. 2.14).

4.4.2 Groundwater

The migration of radioactive or other contaminants by groundwater movement is an environmental concern resulting from the operation of ORGDP. Under certain conditions, transport over large distances can occur in groundwater, and groundwater can also become a means by which contaminants are transmitted to surface streams. The three basic parameters that affect groundwater movement are hydraulic gradient, permeability, and aquifer length.

the withdrawals currently are 2.5% of the flow; the 1984 value will be 3.7%. Since peak ichthyoplankton densities occur in the late spring,[45] when river flows are generally high, it is unlikely that these latter values will ever be reached during the time when the ichthyoplankton community is most vulnerable. Moreover, the data of Loar et al.[45] suggest that (1) tributary streams have much greater densities of ichthyoplankton than the Clinch River itself and that most entrainable larvae remain in the tributaries and (2) ichthyoplankton in the river below Poplar Creek in the vicinity of the intake are largely homogeneously distributed, thus lessening the probability that any high concentrations of larvae ever exist near the intake.

Impingement impacts. The water velocity at the trash racks of the intake is currently about 0.1 fps. At this velocity, little debris collects on the traveling screens, and the screens are therefore only run sporadically. No record of impinged fish exists.[46] In the 1984 operating mode, the approach velocity will increase to about 0.2 fps. Although a few fish may be impinged under these conditions, losses are not expected to be severe. In several cases, approach velocities of $\leq$0.5 fps have been found adequate to avert substantial impingement losses.[47,48] Moreover, the swimming speeds of the nonentrainable fish found in the area are likely to be greater than the approach velocity, even in the winter.[49-51]

Thermal impacts. Because of the small volume of water affected by thermal discharges (Sect. 5.3.4), it is not likely that any significant aquatic ecological impacts will occur from the operation of ORGDP. Highly localized impacts that may occur include (1) phytoplankton community composition changes, (2) inhibition or stimulation of photosynthesis (depending on the season and the algal species present) and enhancement of respiration/decomposition, (3) attraction of fish during the colder months, and (4) cold shock of fish during power cutbacks. None of these potential effects is likely to be discernible outside a small area since the largest discharge (cooling tower blowdown) only creates a detectable plume that is a maximum of 60 x 40 x 3 ft (18 x 12 x 0.9 m). Moveover, the ΔT at the discharge point is only 1.7° to 3.3°C (3° to 6°F) (Sect. 5.3.4). In comparison with those of most power-generating facilities, this is a low discharge ΔT, and the plume that is produced is much smaller than that produced by most power plants.[52]

No significant change in the characteristics of the thermal discharges is anticipated for 1984 operation of the facility (Sect. 5.3.3).

Impacts of chemical discharges. Although ORGDP operation has had, and continues to have, a significant effect on the chemical loading of Poplar Creek and the Clinch River, much (if not most) of the serious contamination of these water bodies appears to be derived from upstream sources. The Poplar Creek Watershed receives effluent from coal mining areas, sewage treatment facilities, and the Y-12 Plant. The latter, in particular, is suspected of producing most of the stream burden of mercury near the ORGDP site.

Potential eutrophication impacts induced by the sewage effluents and nitrate discharges in the process wastewater are discussed in Sect. 5.3.3.

As indicated in Sect. 5.3.3, some of the constituents in the effluents are at concentrations that would be toxic to biota if the waste streams were undiluted,[53,54] as might be found in localized areas during periods of zero flow (Table 5.15). Some of these substances occur at concentrations several orders of magnitude greater than the criterion for protection of aquatic biota (e.g., nickel, zinc, and residual chlorine). Thus, significant degradation of the biotic communities could be expected in portions of Poplar Creek and the Clinch River during this worst-case situation. Possible effects include (1) acute and/or chronic toxic effects induced by the parameters listed in Table 5.15, except for dissolved solids and sulfates, (2) community composition changes (especially in phytoplankton, periphyton, and zooplankton) caused by osmotic shifts from the dissolved solids and sulfate additions; and (3) increased bioaccumulation of heavy metals.

Two proprietary chemicals in the effluent at ORGDP discharge location 1 (Betz Polynodic 562 and Betz 35A; Table 2.8) are of unknown toxicity. These chemicals are essentially polyphosphonates, which are thought to be readily degraded. Because the blowdown becomes greatly diluted, the levels of these compounds would not be expected to become significant except in the immediate discharge area.

The frequency of occurrence of zero flows at the ORGDP site is unknown, as is the size of each plume that would be produced by each discharge under no-flow conditions. Thus, it is not possible to quantify the impacts that would occur. Under average flow conditions (Poplar

Table 5.15. Effluent concentrations (1978 operation) at ORGDP discharge locations

Parameter	Protection criterion[a] (mg/liter)	Maximum monthly discharge concentration[b] (mg/liter) Discharge location No.[c]							
		1	2	3	4	5	6	7	8
Ammonia[d]	0.02[e]				0.51				
Cadmium	4×10^{-4}[f]						0.005		
Chlorine (total residual)	0.002				2.0	2.0			
Copper	~0.020[g]		0.50	0.50			0.12		
Cyanide	0.005	0.007		0.006			0.007		
Dissolved solids	h	900	4000	820					
Lead	~0.050[g]		0.07						
Manganese	1.5[i]		2.6						
Mercury	5×10^{-5}	0.004	0.004				0.002		
Nickel	0.005[g]	1.86	2.5	0.800			0.15		
Sulfate	h	500	1200	610			2100		320
Zinc	1×10^{-4}	1.2		0.10			0.50		

[a]U.S. Environmental Protection Agency, *Quality Criteria for Water*, EPA-440/9-76-023, 1976.
[b]Value given only if in excess of protection limit.
[c]Discharge locations are shown in Fig. 2.1.
[d]Unionized NH_3 concentration at maximum reported pH.
[e]In the unionized form.
[f]For sensitive organisms (e.g., cladocerans) in soft water.
[g]Based on 0.1×96-hr LC_{50}, using a sensitive aquatic species.
[h]A concentration that does not induce changes in community composition.
[i]Minimum tolerance value for a sensitive organism.

Creek, 200 cfs; Clinch River, 4800 cfs) all the parameters would be reduced (outside the mixing zones) to levels unlikely to harm the biota, with the exception of mercury, zinc, and nickel. These metals occur at sufficiently high average and maximum background concentrations (Tables 2.8 through 2.12 and Table 4.7) to potentially induce toxic effects without the ORGDP additions. Mercury, in particular, has been found at highly elevated levels upstream in Poplar Creek (up to 2 μg/liter). Thus, additions from ORGDP will potentially exacerbate any toxic effects that may already be occurring.

Analyses of sediment and fish tissue are potentially useful indicators of the long-term degradation occurring in an environment from heavy-metal inputs. Sediment analyses conducted in the area are reported in Sect. 4.4.1.4. Interpretation of the results of these analyses is somewhat difficult because (1) the precision of many of the tests is low, especially at lower concentrations;[55] (2) sediment texture and organic content can greatly affect metal absorption and retention;[56] and (3) downstream migration of the metals ordinarily occurs with time, complicating a determination of contaminant sources. Furthermore, sediment Eh and pH, which can be quite variable within a given habitat,[57] affect metal retention.[58] Despite these facts, all the heavy metals examined (cadmium, copper, lead, manganese, mercury, nickel, and zinc) appear to be elevated in the vicinity of ORGDP, with the possible exception of cadmium (Sect. 4.4.1.3). Mercury concentrations are substantially greater than those expected in pristine areas (see discussion in Sect. 4.4.1.3). The extent to which ORGDP discharges contribute to the sediment metal burden is as yet unknown. An examination of Table 4.9 indicates that sediment values are high upstream of the facility (station 19; mouth of the East Fork of Poplar Creek).

The results of a 1977 study of trace substances in fish tissues in the vicinity of ORGDP are discussed in detail in ref. 45. In this analysis of 362 fish (including 15 species), only mercury and polychlorinated biphenyls (PCBs) were found at levels indicating contamination (Tables 5.17 through 5.22). Table 5.16 lists selected mean concentrations of trace elements in fish (in relatively uncontaminated areas, as determined by various investigators), and Tables 5.17 through 5.22 give data on the tissue concentrations found at various stations in the Clinch River and Poplar Creek. Generally, migratory species that enter Poplar Creek to spawn had the

Table 5.16. Trace element concentrations in fish — from selected studies

Element	Concentration (µg/g)				
	Lake Erie	Great Smoky Mountains National Park	Great Lakes (Michigan, Superior, and Erie)	Lake Cayuga, N.Y.	Wintergreen Lake, Ill.
Mercury	0.522	0.036			0.18
Lead				0.011	0.329
Cadmium	0.055		0.09	0.04	0.037
Zinc	14.2		1.3	0.21	
Copper	1.08			0.02	
Chromium	0.23		1.0	0.016	
Nickel				0.014	

Source: James M. Loar et al. *Environmental Analysis Report for the Oak Ridge Gaseous Diffusion Plant*, ORNL/TM-6714, Oak Ridge National Laboratory, Oak Ridge, Tenn. (in preparation).

Table 5.17. Mean concentrations of metals and PCBs in fish collected from station PCM 11.0, spring 1977

	Concentration (µg/g wet weight)							
	Hg	Pb	Cd	Zn	Cu	Cr	Ni	PCBs
White bass	0.17 ± 0.008	0.21 ± 0.02	0.008 ± 0.001	5.0 ± 0.5	0.6 ± 0.06	0.09 ± 0.02	0.5 ± 0.04	0.4 ± 0.06
Gizzard shad	0.04 ± 0.002	0.13 ± 0.02	0.007 ± 0.001	4.0 ± 0.3	0.8 ± 0.1	0.16 ± 0.07	0.6 ± 0.1	0.3 ± 0.05
Bluegill	0.10 ± 0.03	0.09	0.023 ± 0.004	8.0 ± 1.4	0.5 ± 0.1	0.29 ± 0.11	0.6 ± 0.2	0.3

Source: James M. Loar et al., *Environmental Analysis Report for the Oak Ridge Gaseous Diffusion Plant*, ORNL/TM-6714, Oak Ridge National Laboratory, Oak Ridge, Tenn. (in preparation).

lowest tissue levels (e.g., gizzard shad and white bass), and resident bottom feeders and top carnivores in the creek had the highest levels. More than 14% of the game fish from Poplar Creek and the Clinch River had muscle tissue mercury concentrations in excess of 0.5 µg/g, whereas 2% of the game fish from all six sites had mercury levels exceeding 1.0 µg/g, the action level on mercury in fish recently recommended by the U.S. Food and Drug Administration (FDA). A largemouth bass from station PCM 5.5 had the highest mercury concentration (2.14 µg/g wet weight) of all the fish collected.

Significant seasonal differences ($p < 0.05$) in tissue concentrations of mercury were found in largemouth bass and *Lepomis* sp. (probably bluegill). Thus, either different populations of fish of these species were sampled, or the same populations were exposed to greater levels of mercury during the season when the highest tissue levels occurred. Differences in available mercury could have resulted from increases in effluent releases into the water column, or additional mercury may have been mobilized from the sediments.[59]

The data indicate that many of the fish have tissue mercury concentrations that exceed a recognized FDA criterion, above which human consumption is not recommended. However, a previous study[60] suggests that the mercury that is contaminating fish comes primarily from sources upstream of ORGDP (in the East Fork of Poplar Creek and in Bear Creek).

Table 5.20. Mean concentration of metals and PCBs in fish collected from station CRM 15.0, 1977

	Concentration (µg/g wet weight)												
	Hg		Pb		Cd		Zn		Cu		Cr	Ni	PCBs
	1[a]	2[b]	1	2	1	2	1	2	1	2	1	2	1
White bass		0.04 ± 0.005		0.12 ± 0.01		0.016 ± 0.003		8.0 ± 0.5		0.3 ± 0.10			
Gizzard shad	0.07 ± 0.01		0.05 ± 0.002		0.008 ± 0.001		2.0 ± 0.1		0.6 ± 0.1		0.36 ± 0.08		0.5 ± 0.2
Lepomis sp.		0.53 ± 0.11		0.08 ± 0.006		0.009 ± 0.001		12.0 ± 0.4		0.3 ± 0.01		0.6 ± 0.03	
Largemouth bass		0.21 ± 0.05		0.19 ± 0.03		0.026 ± 0.004		6.0 ± 0.4		0.1			

[a]1 = fish collected in the spring.
[b]2 = fish collected in the fall.
Source: James M. Loar et al., *Environmental Analysis Report for the Oak Ridge Gaseous Diffusion Plant*, ORNL/TM-6714, Oak Ridge National Laboratory, Oak Ridge, Tenn. (in preparation).

Table 5.21. Mean concentration of metals and PCBs in fish collected from station CRM 11.5, 1977

	Concentration (µg/g wet weight)							
	Hg	Pb	Cd	Zn	Cu	Cr	Ni	PCBs
Gizzard shad	0.10 ± 0.01	0.32 ± 0.05	0.020 ± 0.006	9.0 ± 1.5	0.8 ± 0.4	0.04 ± 0.003		
Shad	0.05 ± 0.005	0.10 ± 0.01	0.014 ± 0.008	4.0 ± 0.4	0.6 ± 0.05	0.10 ± 0.03	0.7 ± 0.2	0.4 ± 0.06
Lepomis sp.	0.49 ± 0.14	0.30 ± 0.02	0.014 ± 0.001	11.0 ± 1.4	0.4 ± 0.03	0.04 ± 0.005		

Source: James M. Loar et al., *Environmental Analysis Report for the Oak Ridge Gaseous Diffusion Plant*, ORNL/TM-6714, Oak Ridge National Laboratory, Oak Ridge, Tenn. (in preparation).

Tissue concentrations of PCBs in the fish were also determined because elevated sediment values were found (Sect. 4.4.1.4). Most of the fish analyzed had concentrations below the FDA action level of 5 µg/g. However, concentrations near this level were found in the ten channel catfish collected in Poplar Creek. Two fish had levels as high as 6.0 and 7.0 µg/g, but the highest body burden — 8.5 µg/g — was found in a longnose gar from the creek.

The source of PCB contamination is unknown. No PCBs of the same chemical composition as those found in the area have been used by ORGDP in recent years; data are lacking on what compounds may have been discharged before this time.[61] Although sediment levels are lower upstream of the facility, downstream migration of the compounds from an upstream source is highly possible.

The physical and chemical milieus of the waters near ORGDP (especially Poplar Creek) suggest that the biotic communities within them are under stress. The stressors are many and varied — turbidity, allochthonous sediment (especially coal fines), heavy metals and other toxicants, degradable organic matter, excessive nitrogen and phosphorus, altered flow regimes, altered water temperatures. Despite this, functioning communities exist and, in some cases, thrive. Thus, a phytoplankton, zooplankton, and periphyton assemblage fairly typical of North American rivers exists (Sect. 4.6.2), and Poplar Creek apparently serves as a major spawning and nursery ground for fish. However, some changes in community and ecosystem structure and function undoubtedly have occurred as a result of these anthropogenic disturbances. Moreover, stressed systems are highly susceptible to the effects of additional perturbations. It is therefore advantageous to curb, where possible, the input of existing or additional factors that may affect the biota of Poplar Creek and the Clinch River. Moreover, the potential health effects resulting from the consumption of mercury- and PCB-laden fish caught in the area dictates careful monitoring of contaminant levels. Also, upstream sources of mercury and PCBs need to be determined and evaluated, with the aim of reducing their effects. An assessment of Y-12 operations (in preparation) will give additional information on upstream sources.

Radiation dose to aquatic biota. Doses to aquatic plants, to invertebrates, and to fish and waterfowl that live in the receiving water bodies below effluent discharge regions have been calculated. These doses are due to water intake and ingestion by organisms living in water bodies that receive the liquid effluent. The discharge-region concentrations were calculated from average annual radionuclide releases and from average annual flows for the receiving water bodies (see Table 5.9).

All dose calculations were based on the assumption that the radionuclide concentrations in water remain constant and that the biota reach a steady-state concentration where the input of radioactive material to the environment is constant. The organisms are assumed to spend all year in Poplar Creek water that has the maximum concentration of discharged radionuclides. All calculations were completed by use of adaptions of standard models and procedures for estimations of radiation dose (see ref. 6). However, the doses are probably conservative, since it is highly unlikely that any of the mobile life forms spend a significant portion of their life span at the site of maximum concentration of radioactivity.

Tables 5.23 and 5.24 list the radiation doses calculated for organisms living in or near the discharge of liquid effluents from ORGDP into Poplar Creek. Aquatic plants and invertebrates are estimated to receive the highest internal doses, which are mainly attributable to uranium-234.

Table 5.23. Estimated annual internal dose resulting from liquid effluents to biota that live in Poplar Creek at the ORGDP boundary

Radionuclide	Concentration (μCi/ml)	Dose (millirads)			
		Algae	Invertebrates	Fish	Waterfowl or muskrats
Tc-99	1.5E−8[a]	1.0	1.3E−1	3.9E−1	7.6E−2
U-234	9.6E−10	8.8E2	8.8E1	8.8	1.2
U-235	4.6E−11	3.9E1	3.9	3.9E−1	5.5E−2
U-236	1.5E−11	1.3E1	1.3	1.3E−1	1.8E−2
U-238	6.6E−10	5.3E2	5.3E1	5.3	7.4E−1
		1.5E3	1.5E2	1.5E1	2.1

[a] Read as 1.5×10^{-8}.

The significance of these estimated radiation doses to biota other than man is not immediately known. The literature on radiation effects on organisms is extensive, but very few studies have been conducted to determine the effects of continuous low-level exposure to radiation from ingested radionuclides on natural aquatic or terrestrial populations. The most recent pertinent studies point out that, whereas the existence of extremely radiosensitive biota is possible and increased radiosensitivity in organisms may result from environmental interactions, no biota have yet been discovered that show more sensitivity to radiation exposure than those found in the area surrounding ORGDP. The BEIR report states, in summary, that evidence to date indicates that no other living organisms are very much more radiosensitive than man.[62]

Operation of the Oak Ridge Gaseous Diffusion Plant (ORGDP) can be categorized in terms of a trade-off between local environmental and socioeconomic costs and socioeconomic and technological benefits, which have local and national impact.

10.1 COSTS

Environmental costs are summarized (Table 10.1) according to:

1. impacts from the existence and operation of ORGDP and the offsite power plants that serve it, transmitted via natural water bodies, the air, and the land
2. consumption of natural resources

✓ In general, there is no manifestation of major environmental costs to the Oak Ridge area caused by the operation of ORGDP. Most of the aquatic impacts measured have been relatively small (Table 10.2). High concentrations of mercury and polychlorinated biphenyls (PCBs) in the sediment of the Clinch River and Poplar Creek are probably not attributable to ORGDP. Atmospheric impacts are small and only locally effective even when potential air quality deterioration from fluorine, sulfur dioxide (SO_2), and cooling-tower drift emissions has been considered.

✓ The socioeconomic costs associated with ORGDP should be viewed within the context of the socioeconomic environment brought about by the presence of the entire federal complex at Oak Ridge. The three local entities predominantly affected by this complex are Anderson and Roane counties and the city of Oak Ridge. When the federally created community of Oak Ridge was established as part of the Manhattan Engineer District program, the two counties felt the impacts of the wartime influx of workers and their families, thousands of daily commuters to the project, and the shortages of manpower and financial resources with which to respond to the new burdens.

Population increases in the early years of the federal project were dramatic for Anderson County and for what came to be the Oak Ridge community. The Anderson County population jumped from 26,504 in 1940 to 59,407 in 1950, while Oak Ridge mushroomed to about 75,000 in 1945 before settling down to a postwar level of 30,000. Roane County experienced a smaller increase in population, 13.9%, in the 1940-1950 decade, although in recent years its federally related population has been increasing more than has that of Anderson. (Population trends since 1940 are shown in Table 10.3.) In a broad sense, the presence of the federal installations and the skills and educational requirements necessary for the U.S. Department of Energy (DOE) programs have accelerated the transformation of the character of two counties from rural and agricultural to urban. The influences of the federal enterprise on income, occupations, and educational levels in the two counties are discussed in depth in a University of Tennessee study prepared for the U.S. Atomic Energy Commission.[1]

This influx of people increased the work load on county governments, principally in the fields of legal services, road maintenance, and education. Some idea of the magnitude of the increased use of roads can be obtained from Table 10.4, which shows the number of license plates sold in the county immediately before the establishment of Oak Ridge; at the height of employment, 1944 to 1945; and in 1972. Since road maintenance costs are borne by county shares of the state tax on motor vehicle fuels, they have not been considered as a significant burden in this analysis.

Burdens on the school systems started with the influx of workers who settled in both the rural and urban areas of the counties. High-quality school curricula have been sought by the population for their own families and by the management of the federal complex in the interests of attracting the highly trained specialists necessary for Oak Ridge operations. The city of Oak

10.3 EFFECT OF ORGDP SHUTDOWN

Shutdown of the ORGDP would make it impossible for the government to fulfill its obligations to provide enriched uranium to the nuclear power industry, domestic and/or foreign, and would result in a loss of revenue and a probable crisis in international relations. On the other hand, the environmental costs associated with ORGDP operations (discards and discharges to the environment and the consumption of natural resources) would disappear.

The TVA would have to, temporarily at least, curtail operations at some of its power-generating facilities. This would result in some reductions of gaseous emissions and liquid discards to the environment (an environmental benefit) but would also result in a layoff of employees (a socioeconomic cost).

Furthermore, ORGDP shutdown would incur the following socioeconomic costs.

1. Substantial unemployment and a depressed economy in the areas relying on ORGDP for payroll and purchases.
2. A tremendous burden on the welfare agencies in the same areas.
3. Increased delinquencies in property taxes and a decline in other tax receipts as family purchases are reduced. The decrease in local government revenues when welfare demands increase would create financial difficulties.

The shutdown of ORGDP would create socioeconomic costs of such magnitude that they could not be counterbalanced by the minor environmental benefits achieved.

10.4 TRADE-OFF DISCUSSION

*✓ The major costs associated with the operation of the ORGDP are environmental, whereas the major benefits are socioeconomic. In addition, through the enrichment of uranium, nuclear power is enabled to develop, reducing reliance on fossil fuels for electricity generation and also reducing health hazards associated with fossil fuel use.

*✓ A critical evaluation of impacts found no threat to human life — no significant intrusion of toxic materials into the human food chain — and no evidence of major harm to local wild animals, birds, plants, or aquatic life. On the other hand, the socioeconomic benefits are considerable: the amount of power made available to serve the nation and the rest of the world, the reduction in the U.S. balance-of-trade deficit through income from separative work sales to foreign governments, the potential reduction of crude-oil imports, the environmental benefits from decreased use of coal for power generation, and the economic benefits to the local economic system because of plant payroll and purchases.

After an analysis of the trade-off between costs and benefits associated with ORGDP, the staff concludes that the net benefits of plant operation greatly exceed the costs.

11. LIST OF PREPARERS

1. Summary

   J. W. Boyle — Environmental Statements Project, Energy Division, ORNL

2. Description of Oak Ridge Gaseous Diffusion Plant

   M. E. Mitchell — Environmental Management Group, ORGDP

3. Alternatives

   J. K. Alexander — Safety and Environmental Control Division, Oak Ridge Operations, DOE

   G. L. Love — Safety and Environmental Control Division, Oak Ridge Operations, DOE

4. Characterization of the Affected Environment

   4.1 Regional demography

   R. C. DeVault — Social Impact Analysis Group, Energy Division, ORNL

   4.2 Land use

   A. M. Solomon — Environmental Impact Program, Environmental Sciences Division, ORNL

   4.3 Geology

   J. R. Gauthier — Energy Systems Planning Division, TRW, Inc., Oak Ridge, Tenn.

   4.4 Hydrology

   J. R. Gauthier — Energy Systems Planning Division, TRW, Inc., Oak Ridge, Tenn.

   S. B. Gough — Environmental Impact Program, Environmental Sciences Division, ORNL

   4.5 Meteorology

   J. P. Witherspoon, Jr. — Technical Assessment Section, Health and Safety Research Division, ORNL

   4.6 Ecology

   S. B. Gough — Environmental Impact Program, Environmental Sciences Division, ORNL

   A. M. Sasson — Environmental Impact Program, Environmental Sciences Division, ORNL

   A. M. Solomon — Environmental Impact Program, Environmental Sciences Division, ORNL

   4.7 Regional landmarks

   A. M. Solomon — Environmental Impact Program, Environmental Sciences Division, ORNL

   4.8 Community characteristics

   R. C. DeVault — Social Impact Analysis Group, Energy Division, ORNL

11. (Cont.)

5. Environmental Consequences

5.1 Human environment

S. J. Cotter	Technical Assessment Section Health and Safety Research Division, ORNL
R. C. DeVault	Social Impact Analysis Group Energy Division, ORNL
G. S. Hill, Jr.	Technical Assessment Section Health and Safety Research Division, ORNL

5.2 Ecological environment

S. B. Gough	Environmental Impact Program Environmental Sciences Division, ORNL
A. M. Solomon	Environmental Impact Program Environmental Sciences Division, ORNL

5.3 Physical environment

S. B. Gough	Environmental Impact Program Environmental Sciences Division, ORNL
A. M. Solomon	Environmental Impact Program Environmental Sciences Division, ORNL

5.4 Impacts of offsite power production

R. B. Craig	Environmental Impact Program Environmental Sciences Division, ORNL

5.5 Potential accidents

S. J. Cotter	Technical Assessment Section Health and Safety Research Division, ORNL
S. B. Gough	Environmental Impact Program Environmental Sciences Division, ORNL
G. S. Hill, Jr.	Technical Assessment Section Health and Safety Research Division, ORNL
A. M. Solomon	Environmental Impact Program Environmental Sciences Division, ORNL

6. Unavoidable Adverse Environmental Effects

S. B. Gough	Environmental Impact Program Environmental Sciences Division, ORNL

7. Irreversible and Irretrievable Commitments of Resources

J. W. Boyle	Environmental Statements Project Energy Division, ORNL

8. Relationship of Land-Use Plans, Policies, and Controls

J. W. Boyle	Environmental Statement Project Energy Division, ORNL

9. Relationship Between Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

J. W. Boyle	Environmental Statements Project Energy Division, ORNL

10. Environmental Trade-Off Analysis

R. B. Schappel	Operations Analysis and Planning ORGDP

Appendix A — Geologic Formations of the Oak Ridge, Tennessee, Area

J. R. Gauthier	Energy Systems Planning Division TRW, Inc., Oak Ridge, Tenn.

11. (Con't.)

Appendix B — Environmental Measurement and Monitoring

J. M. Loar Environmental Impact Program
Environmental Sciences Division, ORNL

A. M. Sasson Environmental Impact Program
Environmental Sciences Division, ORNL

A. M. Solomon Environmental Impact Program
Environmental Sciences Division, ORNL

ATTACHMENT 5

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

June 11, 1982

TO: C. R. Boston

FROM: R. D. Roop R. D. Roop

SUBJECT: Mercury Contamination

The draft Environmental Analysis of the Operation of ORNL (ORNL-5870) identifies mercury contamination as probably the most significant non-radiological water quality degradation resulting from ORNL's operations. In your comments to me on the ORNL-EA, you indicated that this issue is likely to attract attention and that I should be prepared to provide information with which a reader could "put the issue into perspective". This memo provides additional background information on the possible sources of mercury contamination and its significance.

Because I had heard a vague report that mercury contamination was associated with Bldg. 4501, I asked John Boyle about past activities in the building. He confirmed that mercury had been used in the high-bay area of 4501 and referred me to John Drury. Boyle also noted that the building has drainage problems. The high-bay area is equipped with a sump, and during wet periods the pump would remove water from the sump almost continuously.

John Drury indicated that during the 1950's R&D on a lithium-isotope separation process were performed in Bldg. 4501. A small pilot plant, which used "ton quantities" of mercury, was set up in the high-bay area. The process was competing with the one used at Y-12 on a large scale, although the process under development at X-10 did not pan out. (Details of the lithium-isotope separation process are classified; however some of the unsuccessful aspects of the process development research were subsequently declassified.) Drury noted that, because of its density, mercury is difficult to work with. It can cause breakage of glassware, tubing, etc., and it is very difficult to clean up if spilled. Drury indicated that substantial quantities of mercury were undoubtedly spilled. He referred me to Ray Blanco, who was in charge of the project.

Blanco said that the pilot plant operated for approximately six months. In addition, there was associated experimental work which took place in the laboratories surrounding the pilot plant, and Blanco said that quantities of mercuric nitric acid were probably dumped down the lab drains after experiments. He was unable to tell me about the quantities of mercury spilled during pilot plant operation or any procedures attempted for cleanup. Blanco also suggested that we should estimate the mercury emissions from the power plant stack.

UCN-430
(3 5-61)

I can see three possible routes for the entry of mercury into the White Oak Creek system. First is the lab drains, second is water pumped from the sump of the high-bay area, and third, mercury may have entered the groundwater and subsequently reached the Fifth Street Branch or White Oak Creek.

The extent of mercury contamination can be summarized as follows: (1) fourteen bluegill collected from White Oak Lake and from White Oak Creek Embayment contained an average level of mercury in muscle approximately 5 times greater than the level in bluegill from the Clinch River (0.66 vs. 0.14 μg/g); (2) the FDA action level for mercury in fish muscle is 1.0 μg/g; (3) one out of 20 fish collected from the Clinch River had a mercury level exceeding the action level, while 2 out of 14 fish from the White Oak Creek system exceeded the level; (4) concentrations of mercury in water of White Oak Creek downstream from ORNL vary from 0.2 to 0.4 μg/L, while concentrations upstream from ORNL are 0.02 μg/L; (5) average concentrations in White Oak Creek exceed the EPA criterion of 0.14 μg/L, but so do the ambient average levels of 0.36 μg/L in the Clinch River at Melton Hill Dam (reason for these levels unknown); and (6) average concentration of mercury passing White Oak Dam is 0.09 μg/L, below the EPA criteria level.

There is no indication of any substantial discharge of mercury in ORNL wastewaters, and the pattern of contamination suggests to me that the current problem is due at least in part to contamination of sediments resulting from past discharges. Unfortunately, there are essentially no data on the concentrations of mercury or most other contaminants in sediments of White Oak Lake.

The principal problem with the mercury is the possible ingestion of contaminated fish by sport fisherman who take fish from the Clinch River in the 3-5 km reach below Melton Hill Dam. The risk is fairly small, since the average levels of mercury in fish in the Clinch are in the "safe" range and the incidence of fish which exceed the action level appears to be small (roughly 5%). However, since sediments and fish do occasionally pass over White Oak Dam, White Oak Creek may be contributing to the problem. This may attract unwanted attention to ORNL.

The question of mercury contamination takes on added relevance because of recent data collected from East Fork Poplar Creek and Bear Creek. During Spring, 1982, a special task force in Environmental Sciences Division sampled mercury in organisms in these creeks, finding quite high levels (up to 30 μg/g). These data suggest that very high levels of mercury are present in fish in the populated areas of Oak Ridge, areas with no restrictions on fishing. The most extensive data on mercury in fish are available in the background aquatic studies for K-25. These data show that, upstream of K-25 but downstream from the confluence of Poplar Creek with East Fork Poplar Creek, the average mercury level for 90 fish was 0.30 μg/g, and 2% of the fish had levels exceeding 1.0 μg/g. Two largemouth bass had levels of 2.14 and 1.67 u/g, and 3 channel catfish had an average level of 0.52 μg/g. These levels were measured some 15-20 stream miles downstream from Y-12, the presumed source of contamination.

Thus, ORNL's mercury problem is almost trivial compared to other problems on the DOE reservation. Nonetheless, it represents a situation which undoubtedly merits further investigation so that a more complete assessment of risk can be made.

RDR/swp

CC: J. W. Boyle
H. E. Zittel

bcc: Gough

ATTACHMENT 6

CONFIDENTIAL **OFFICE MEMORANDUM**

TO: W. Van Winkle

FROM: S. B. Gough

DATE: 14 April 1982

SUBJECT: Status report--U.S.G.S. joint study with me re mercury, et al. in E. Fork Poplar Cr.

Persuant to Auerbach's call to the U.S.G.S. on 12 April regarding the sensitive data collected on Poplar Creek, my brother, Dr. Larry Gough, has turned over the original field notes, his lab report and any other pertinent information to his branch chief for shipment to Dr. Auerbach. Because of this wrinkle in this study, it is not likely that any data will be publicly released (i.e., in open file format); however, the U.S.G.S. personnel have made it clear that they will not perjure themselves if, for example, a request is made under the Freedom of Information Act. I view this latter possible avenue of receipt of the data as rather unlikely, however.

Before Dr. Auerbach imposed the freeze on data collection, Arsenic values were obtained. For your information, they follow the same declining (but elevated) pattern as mercury, although the values are not as excessive as mercury. For example, the (3) sites on Poplar Cr. were: 12 mg/l (min.; was to be redone--may be as high as 15), 4 mg/l, and 1.5 mg/l. For this metal in plant tissue their level of detection is currently 0.05 mg/l. I personally have not looked at the literature to have a good feel for the findings.

UCN-3841
(12358 7-80)

23 June 1983

NOTE: The wrong units were inadvertently used in the discussion above. The term "mg/l" should read "ppm" or "µg/g."

SBG

ATTACHMENT 7

OAK RIDGE NATIONAL LABORATORY

OPERATED BY

UNION CARBIDE CORPORATION

NUCLEAR DIVISION

POST OFFICE BOX X

OAK RIDGE, TENNESSEE 37830

26 March 1982

Dr. Harry A. Tourtelot
Chief, Branch of Regional
Geochemistry
U.S. Geological Survey
Denver Federal Center
Denver, CO 80225

Dear Dr. Tourtelot:

This is to request that you or Dr. Larry Gough send me the official report, and any subsequent addenda, on trace element levels in plant tissue samples collected in the East Fork, Poplar Creek, Oak Ridge, TN in December, 1981 by Dr. Gough and myself. This material will expedite and augment the preparation of a proposal to study metals in Poplar Creek in more detail.

Thank you in advance for the report. Thanks also for the great help given during collection and in sample analysis and interpretation.

Sincerely,

Stephen B. Gough, Ph.D.
Research Associate
Environmental Sciences Division
Aquatic Ecology Section

SUPERVISOR'S APPROVAL________________________________

W. Van Winkle, Head
Aquatic Ecology Section

ATTACHMENT 8

MAILGRAM SERVICE CENTER
MIDDLETOWN, VA. 22645
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Western Union Mailgram

4-024904S152002 06/01/83 ICS IPMMTZZ CSP NVFB
1 7033718316 MGM TDMT FREDERICKSBURG VA 06-01 1142A EST

STEPHEN B GOUGH, PH.D.
8 NORMAN CT
FREDERICKSBURG VA 22401

THIS MAILGRAM IS A CONFIRMATION COPY OF THE FOLLOWING MESSAGE:

7033718316 MGM TDMT FREDERICKSBURG VA 143 06-01 1142A EST
ZIP
WILLIAM RUCKELSHAUS, ADMINISTRATOR
ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON DC 20460
DEAR SIR

IN LIGHT OF EPA'S DIFFICULTY TO DATE IN REGULATING DISCHARGES FROM DOE FACILITIES (E.G., MERCURY AT THE OAK RIDGE Y-12 FACILITY), I STRONGLY URGE A THOROUGH REVIEW BY THE AGENCY OF DOE'S PROPOSED NEW RULES ON "UNCLASSIFIED CONTROLLED NUCLEAR INFORMATION". IT IS POSSIBLE THE NEW RULES WOULD GREATLY INCREASE COMPLIANCE ENFORCEMENT PROBLEMS AND GENERALLY HINDER THE TRANSFER OF INFORMATION PERTINENT TO EPA.

PERHAPS A GENERIC MOU BETWEEN EPA AND DOE COULD BE DEVISED TO FACILITATE THE TRANSFER OF ANY ENVIRONMENTAL INFORMATION CONSIDERED "UNCLASSIFIED CONTROL NUCLEAR INFORMATION" (AFTER APPROPRIATE SAFEGUARDS TO INSURE CONFIDENTIALITY ARE EMPLOYED). IT DOES NOT SEEM PRUDENT, FOR A VARIETY OF REASONS, TO CONTINUE TO ALLOW DOE TO (DE FACTO) REGULATE ITS OWN EMISSIONS, EXCEPT PERHAPS IN REGARD TO THE MOST SENSITIVE SOURCE TERM ENTITIES.

SINCERELY
STEPHEN B GOUGH, PH.D.

11:48 EST